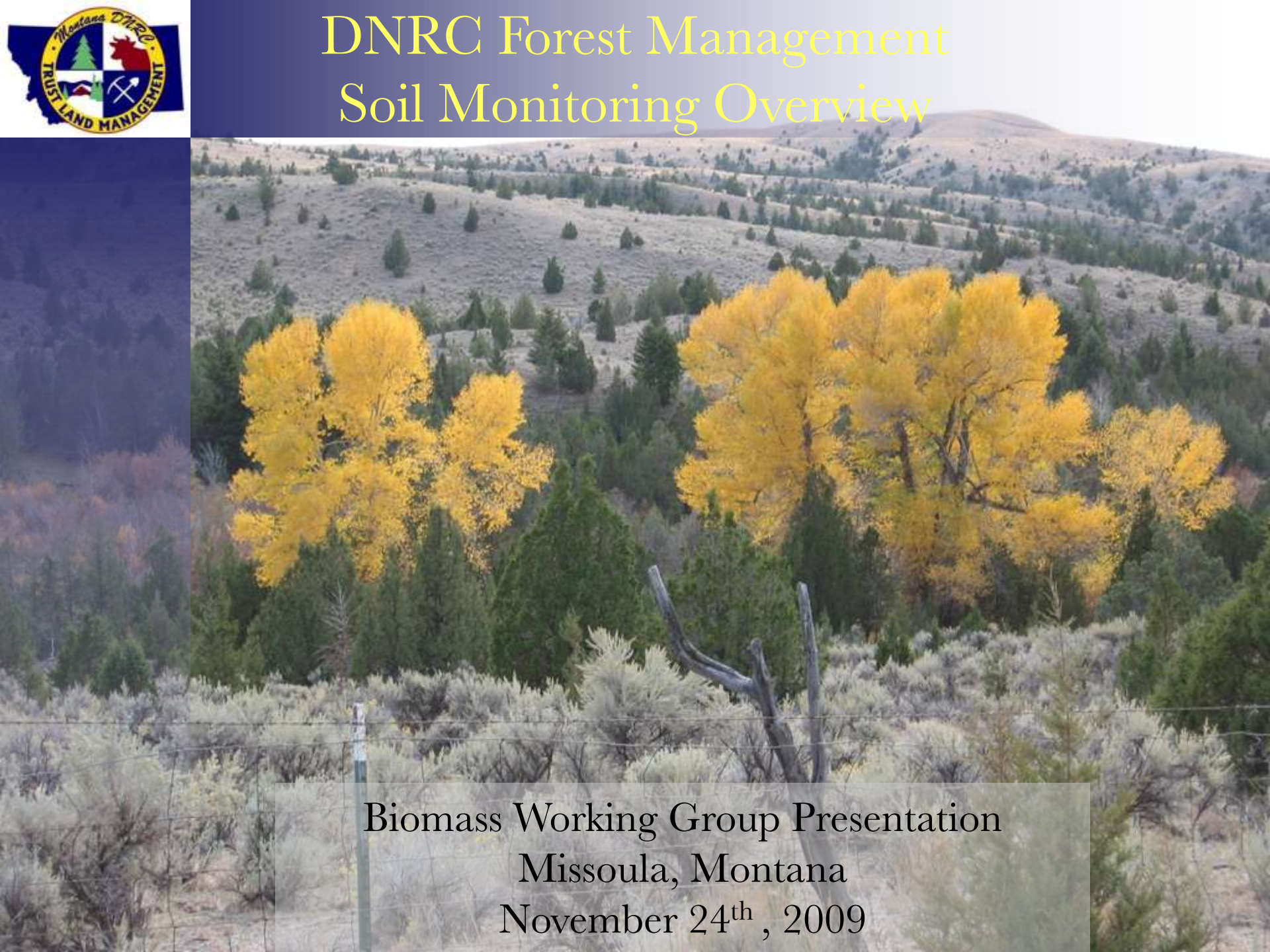
DNRC Forest Management
Soil Monitoring Overview



Biomass Working Group Presentation
Missoula, Montana
November 24th , 2009

DNRC Forest Management Outline

- Overview of Montana Forested Trust Lands
- Management Philosophy and Relevant Plans
- DNRC Soil Monitoring– Past, Present and Future
- Specific Findings and Talking Points Relevant to Biomass Utilization
- Discussion and Questions

A Brief History of Montana Trust Lands

Enabling Act of 1889

- Formally constituted the states of Washington, Montana, South Dakota, North Dakota on February 22, 1889 .
- SEC. 10 and 11, conditional to the admission of each State, granted sections numbered 16 and 36 in every township to permanent reservation for the national purpose of supporting Common Schools.
- Exemplified ideology seeded in Thomas Jefferson's 1779 proposal, *A Bill for the More General Diffusion of Knowledge*. A significant victory in the Common School Movement.

A Brief History of Montana Trust Lands

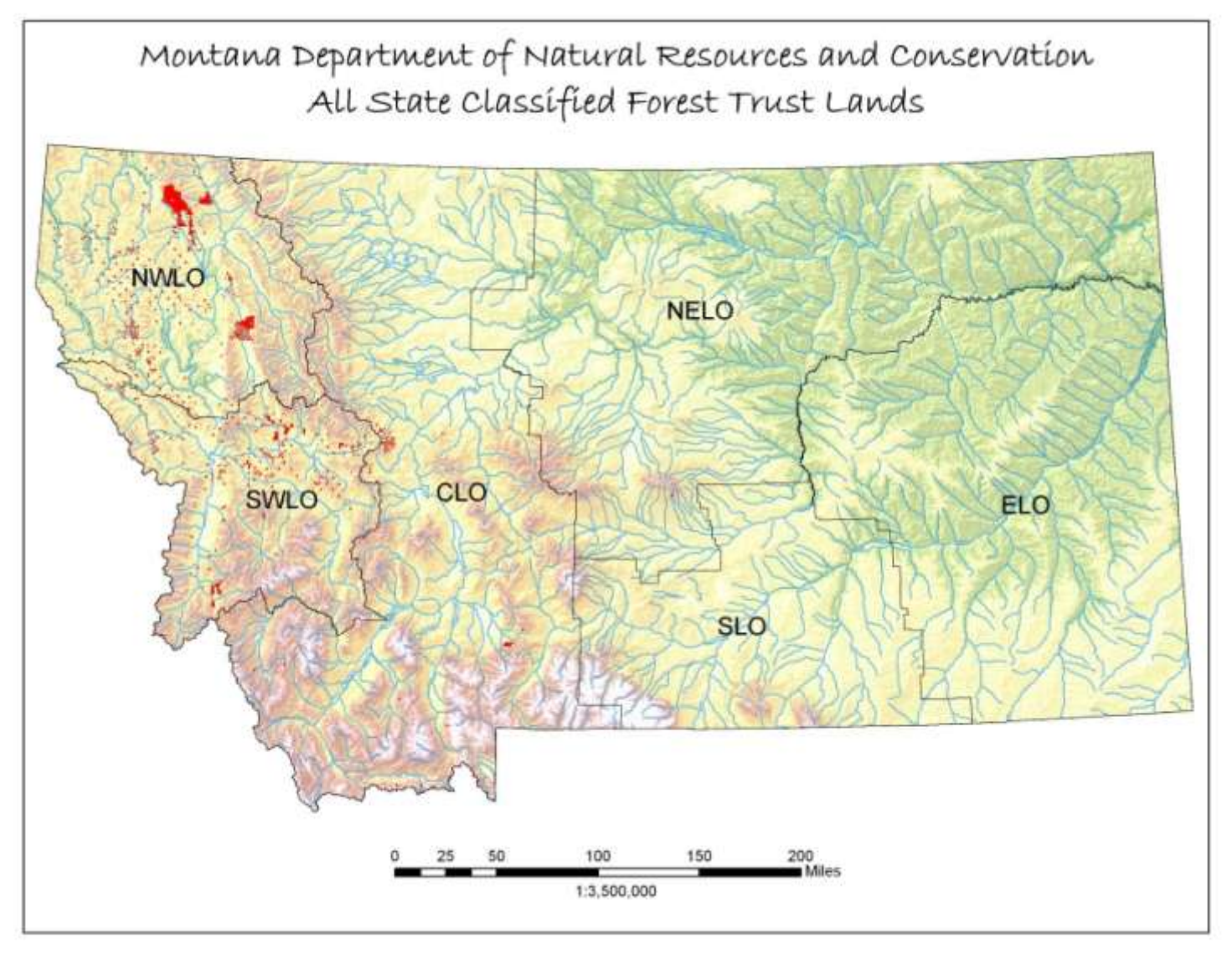
Trust Land Management Division (TLMD)

- A division within DNRC since the Executive Reorganization Act of 1971.
- Approximately 132 FTE in Trust Land Management
  72 FTE in Forest Management

Trust Land Mission

"Manage the State of Montana's trust land resources to produce revenues for the trust beneficiaries while considering environmental factors and protecting the future income-generating capacity of the land"

Trust Lands Overview



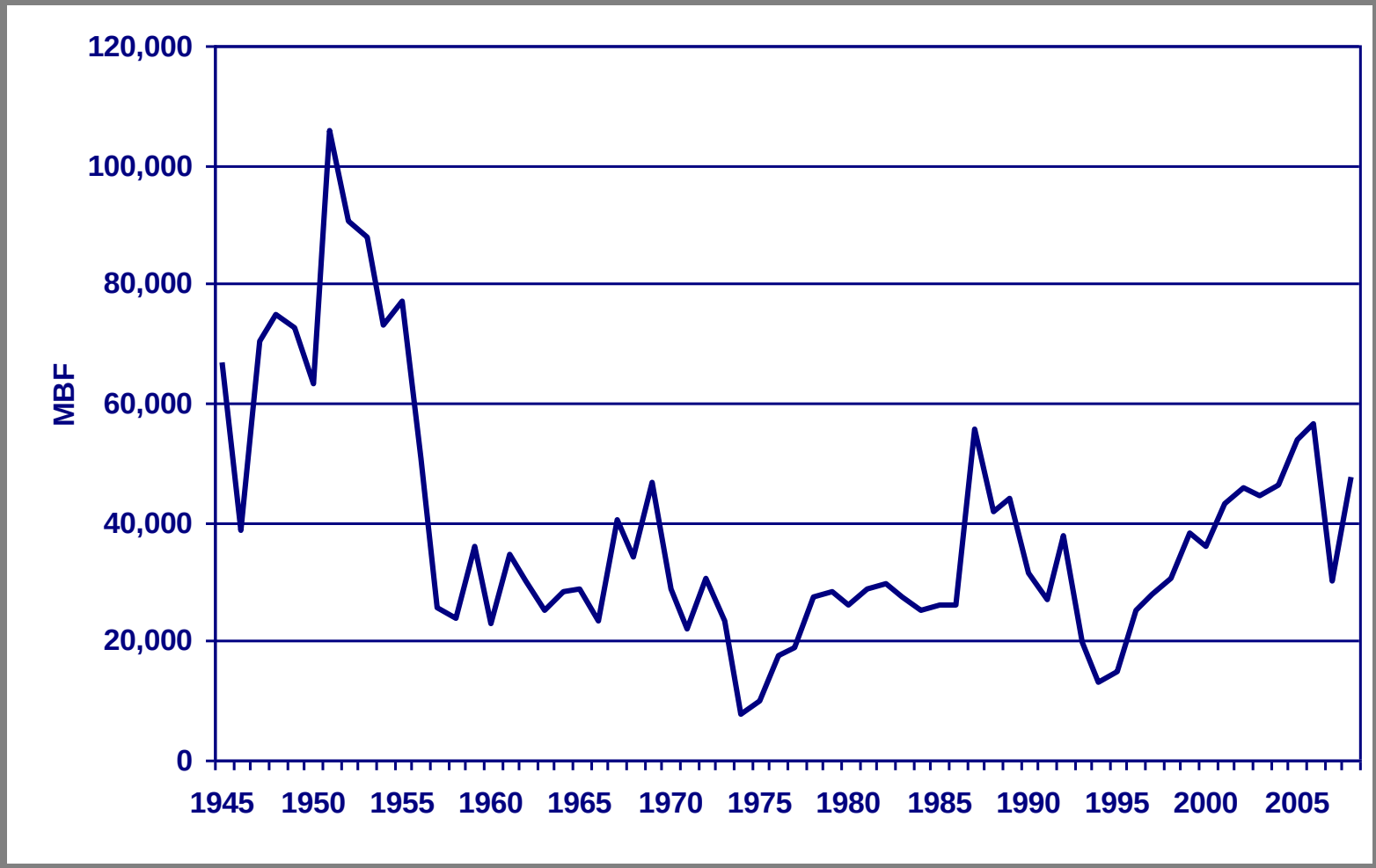
State Forest Land Management Plan

Development of the State Forest Land Management Plan 1996

- Programmatic plan outlining the philosophies and approaches of forest management on State lands.
- *Best way to produce long-term income for the trusts is to manage intensively for healthy and biologically diverse forests.*
- *A diverse forest is a stable forest that will produce the most reliable and highest long-term revenue stream.*
- *In the foreseeable future timber management will continue to be our primary source of revenue and primary tool for achieving biodiversity objectives.*

DNRC Forest Management

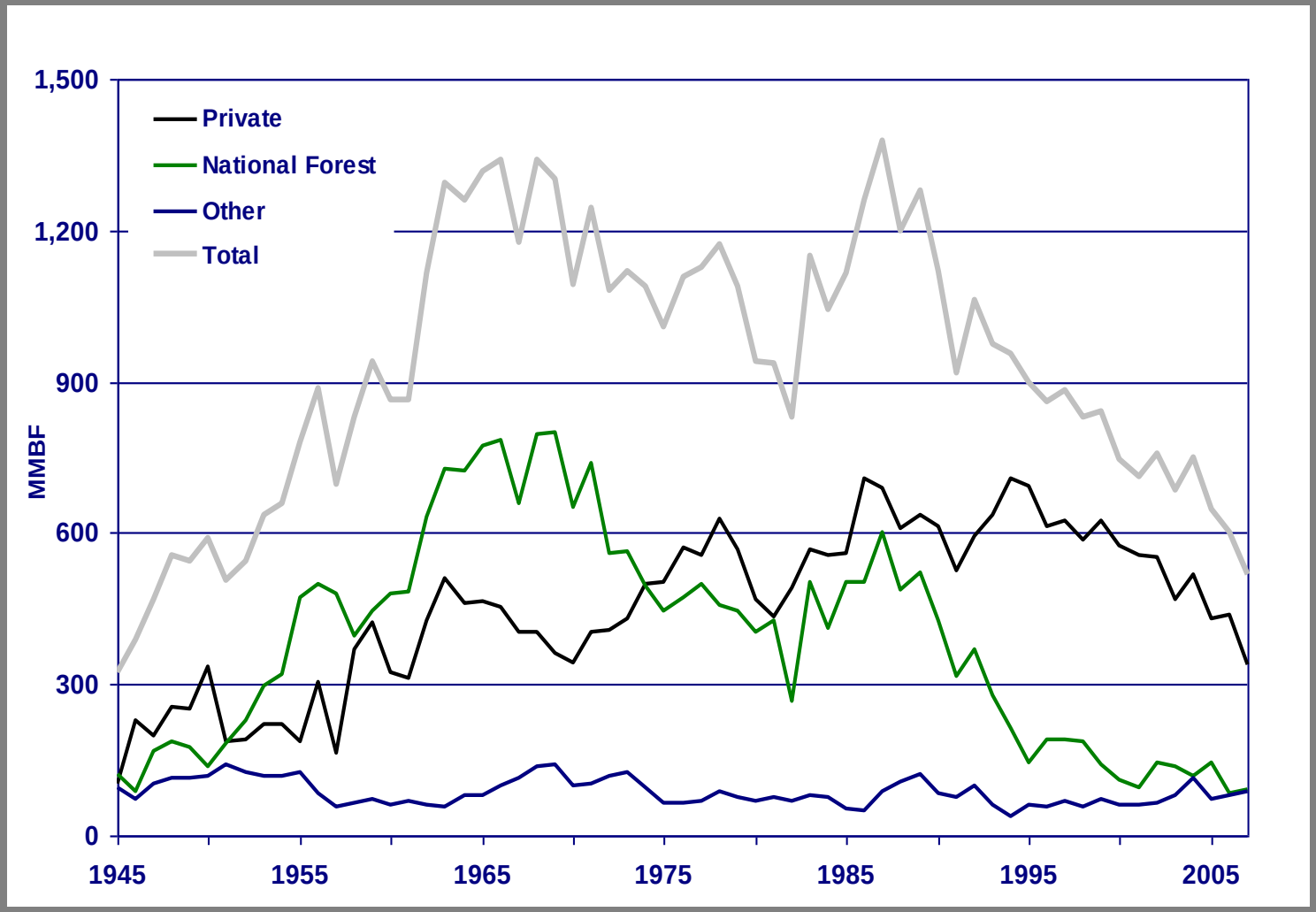
Trends in DNRC Forest Management



Last 50 Years of DNRC Harvest

DNRC Forest Management

Trends in Montana Forest Industries



Industry wide harvest levels (BBER)

State Forest Land Management Plan
Soil Resources

Management-Induced Compaction and Displacement

- Significant impacts should be restricted to 15% of the harvest area.
- "Within a timber harvest area, the loss or damage of soil productive capacity as a result of physical or biological impacts that exceeds 15% of native soil condition is considered significant."

Nutrient Cycling

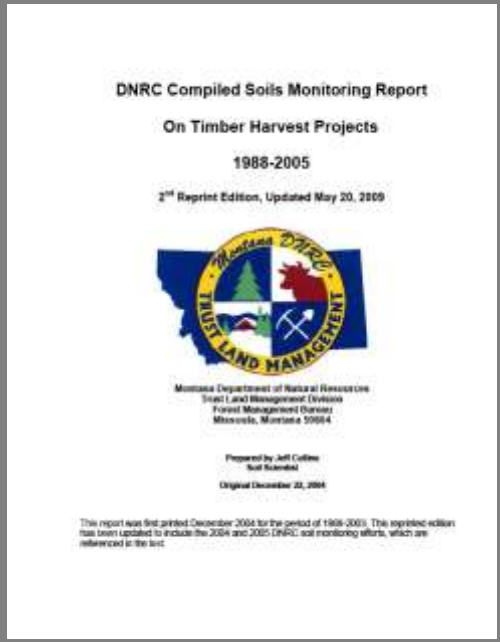
- A significant impact on nutrient cycling is considered to occur when the nutrient removal associated with the activity exceeds the estimated natural rate of replenishment over time.

Adaptive Management

- Requires effectiveness monitoring of mitigation measures as well as impacts to soil resources from DNRC timber sales.

Soil Monitoring

- Began in 1988 employing methods of Howes et al. (1983) and Brown (1974)
- Disturbance monitoring conducted in 94 harvest units covering 4,340 acres
- Approx 124,000 acres harvested in this period...29% of activities monitored.
- Diverse Site Selections:
  - geology and parent materials
  - climates
  - slope, elevation and aspect
  - equipment types and logging systems
  - habitat types and sivilcultural treatments



DNRC Compiled Soils Monitoring Report

On Timber Harvest Projects

1988-2005

2nd Reprint Edition, Updated May 20, 2009

Montana Department of Natural Resources
Trust Land Management Division
Forest Management Bureau
Missoula, Montana 59804

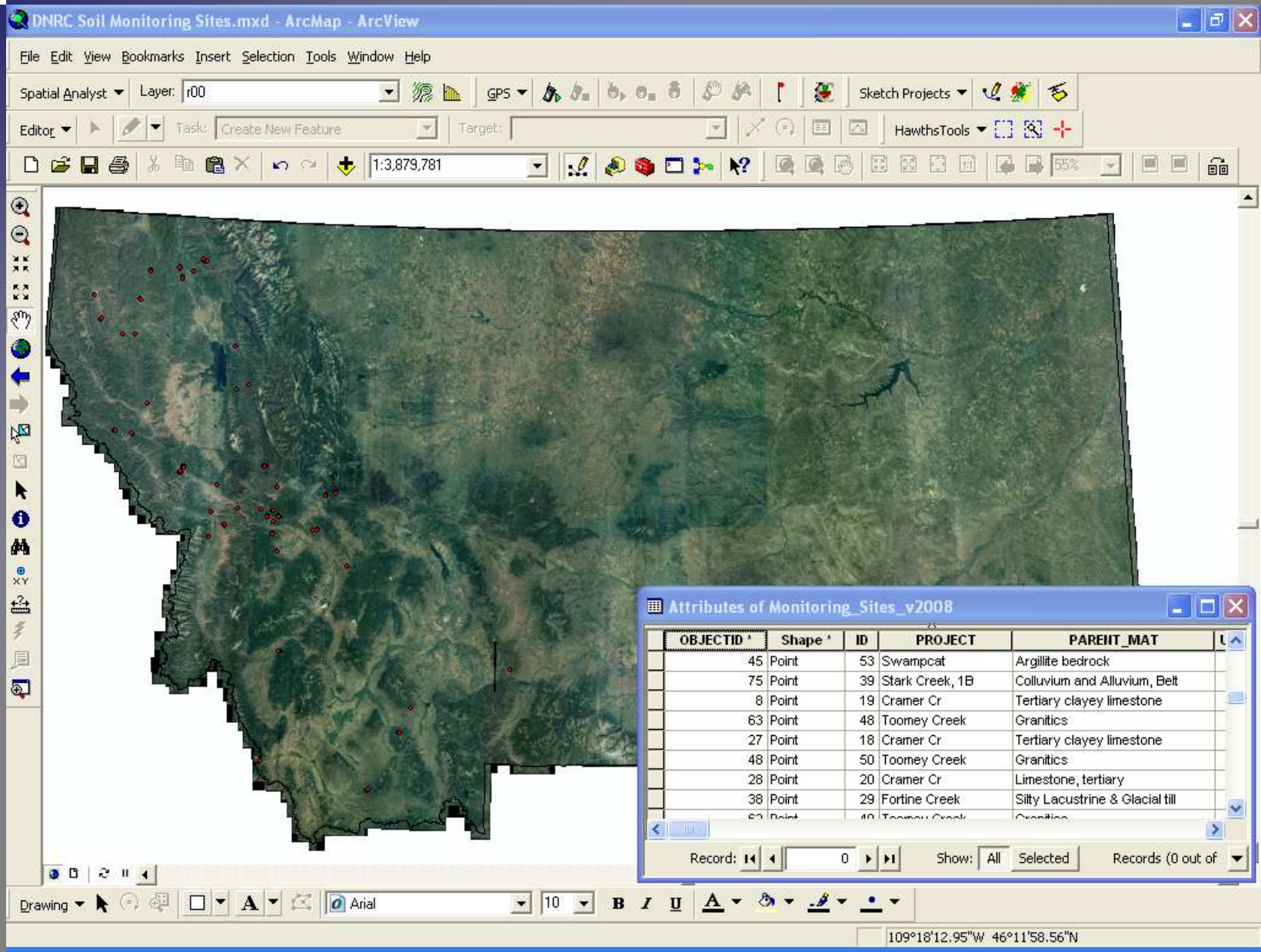
Prepared by Jeff Collins
Soil Scientist

Original December 20, 2004

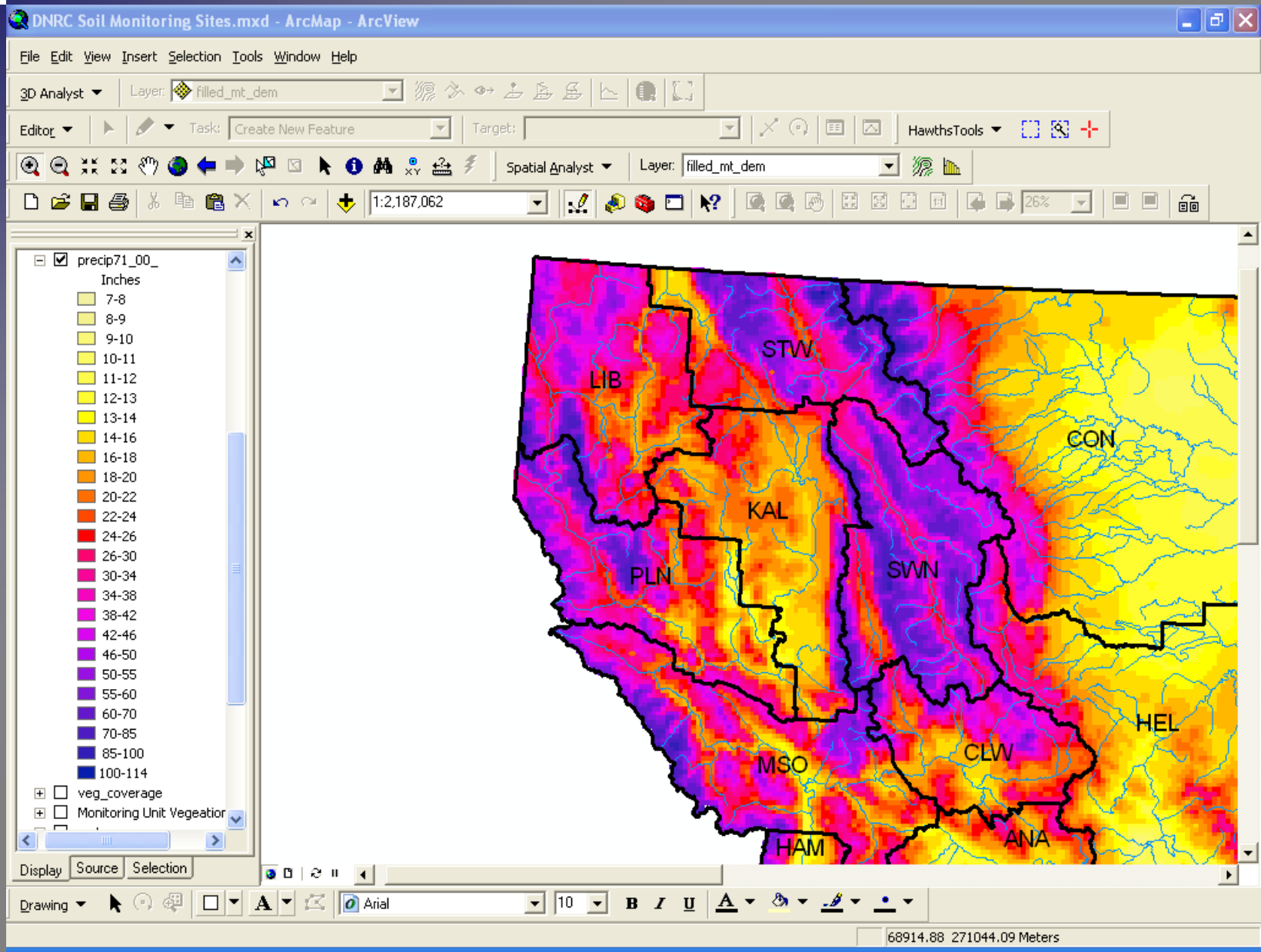
This report was first printed December 2004 for the period of 1988-2003. This reprinted edition has been updated to include the 2004 and 2005 DNRC soil monitoring efforts, which are referenced in the text.

(Available Electronically)

Soil Monitoring



Soil Monitoring



Soil Monitoring – General Results

Tracked and Wheeled Equipment

Average Total Impacts: 14%

Range: 2%-37%

STDV: 9.6

Soil Monitoring – General Results

Feller Buncher/Clippers/RTS

Average Total Impacts: 8%

Range: 0-21%

STDV: 6.3

Soil Monitoring – General Results

Cable Systems

Average Total Impacts: 6%

Range: 2-11%

STDV: 3.4

Soil Monitoring – General Results

Forwarding Systems

Average Total Impacts: >3.0%

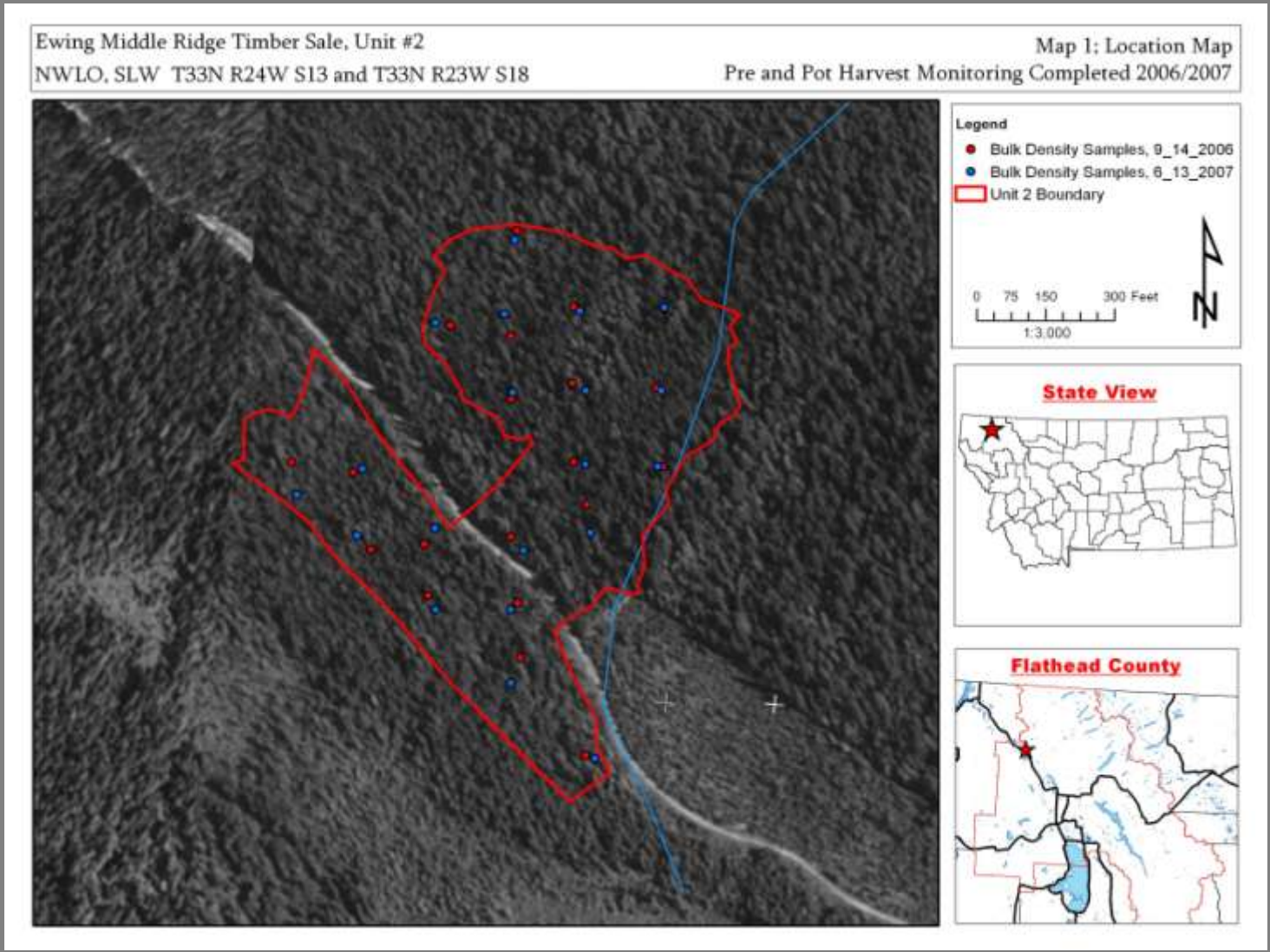
Soil Monitoring – General Results

- Limiting Equipment Operations
  - 20% soil moisture or less, frozen soils, 12" packed or 18" unconsolidated snow.
- Slope Restrictions
  - 40% on ridges, convex slopes; and to 35% or less on concave slopes without winter conditions.
- Skid Trail Location, Design and Spacing
  - Minimum trail spacing of 60 feet with location following BMP's
- Nutrient Cycling
  - *Graham et al. 1994 (CWD)*
  - *Discourage whole tree harvest.*
  - *Retain top on-site for every third load (FWD)*

Point #1: Different logging systems result in varying magnitudes and spatial extents of soil impacts. Slope, soil properties, climates and operator skill are also primary controls. Mitigation measures have been proven effective in limiting disturbance.

Beyond Soil Disturbance Monitoring

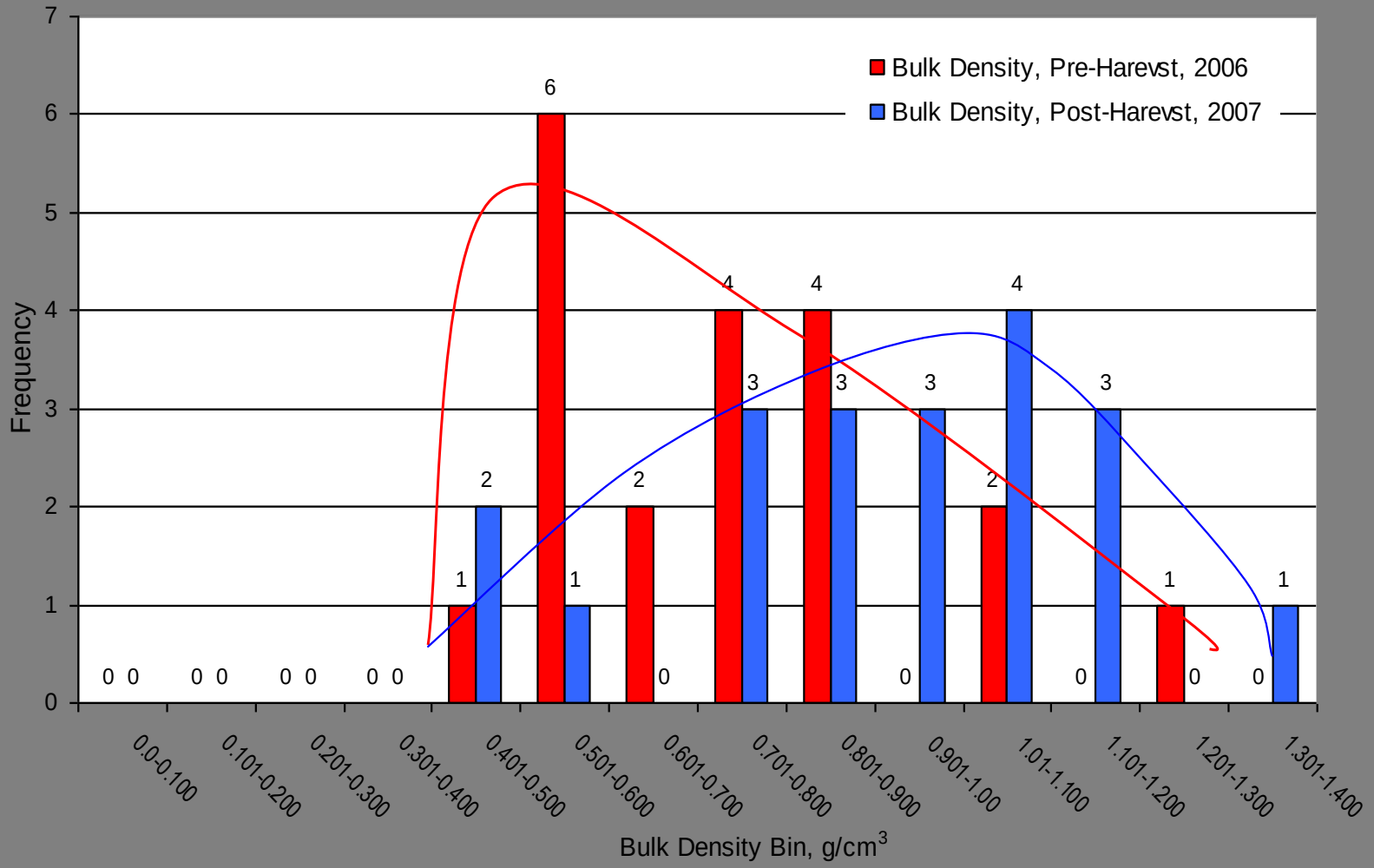
Ewing Middle Ridge Timber Sale - Cumulative Effects



Beyond Soil Disturbance Monitoring

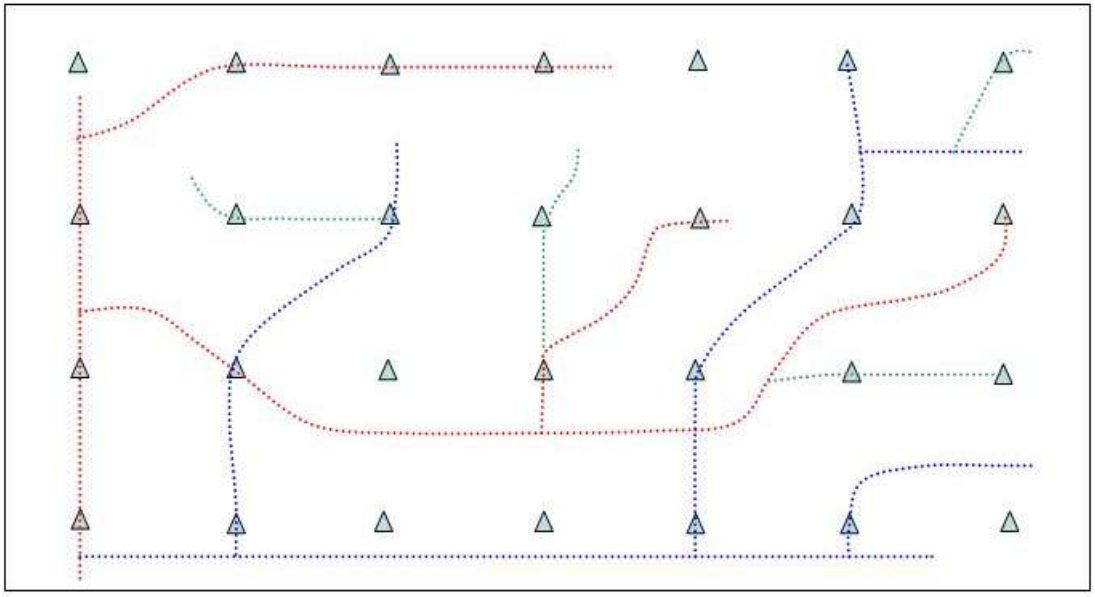
Ewing Middle Ridge Timber Sale - Cumulative Effects

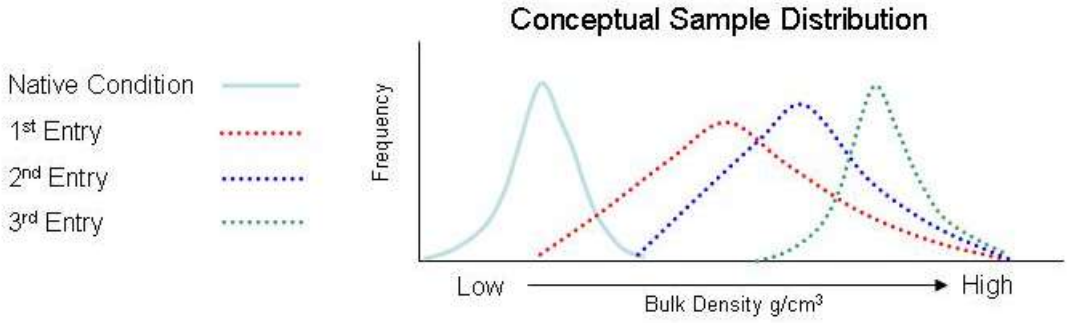
Pre and Post Harvest Soil Bulk Density Sampling, Ewing Middle Ridge, Stillwater State Forest



Beyond Soil Disturbance Monitoring

Ewing Middle Ridge Timber Sale - Cumulative Effects





Beyond Soil Disturbance Monitoring

Similar research findings

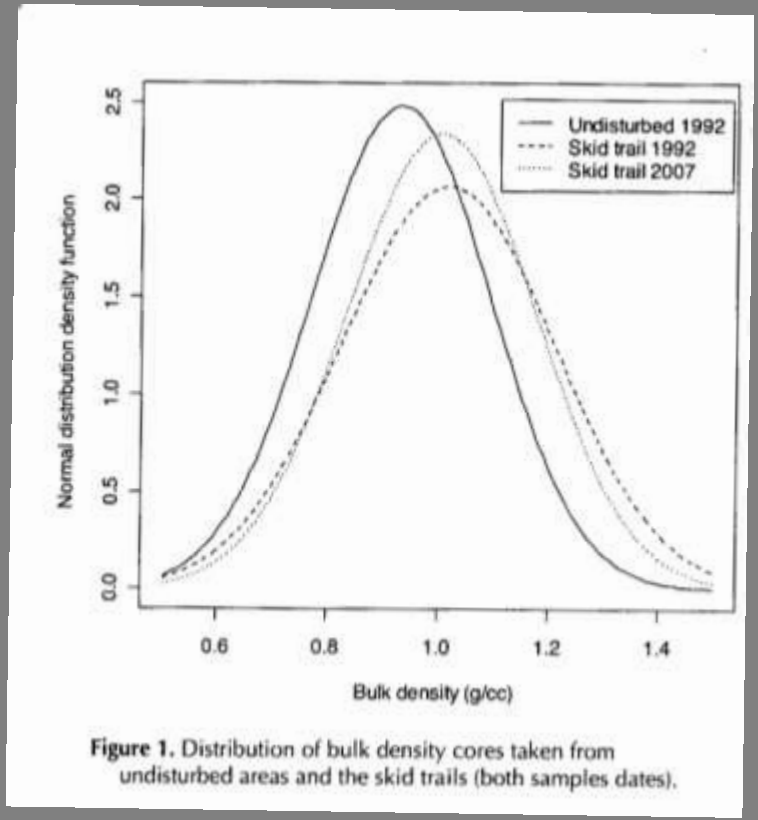


Figure 1. Distribution of bulk density cores taken from undisturbed areas and the skid trails (both samples dates).

Point #2: Multiple stand entries, if not properly mitigated and administered, have to potential to cumulatively effect soil physical properties.

Rawinski and Page-Dumroese, 2008. Soil compaction Monitoring of the Pool Timber Sale, Rio Grande National Forest, Colorado, 16 Years after Logging. USDA RMRS, RMRS-GTR-215. September 2008.

Beyond Soil Disturbance Monitoring

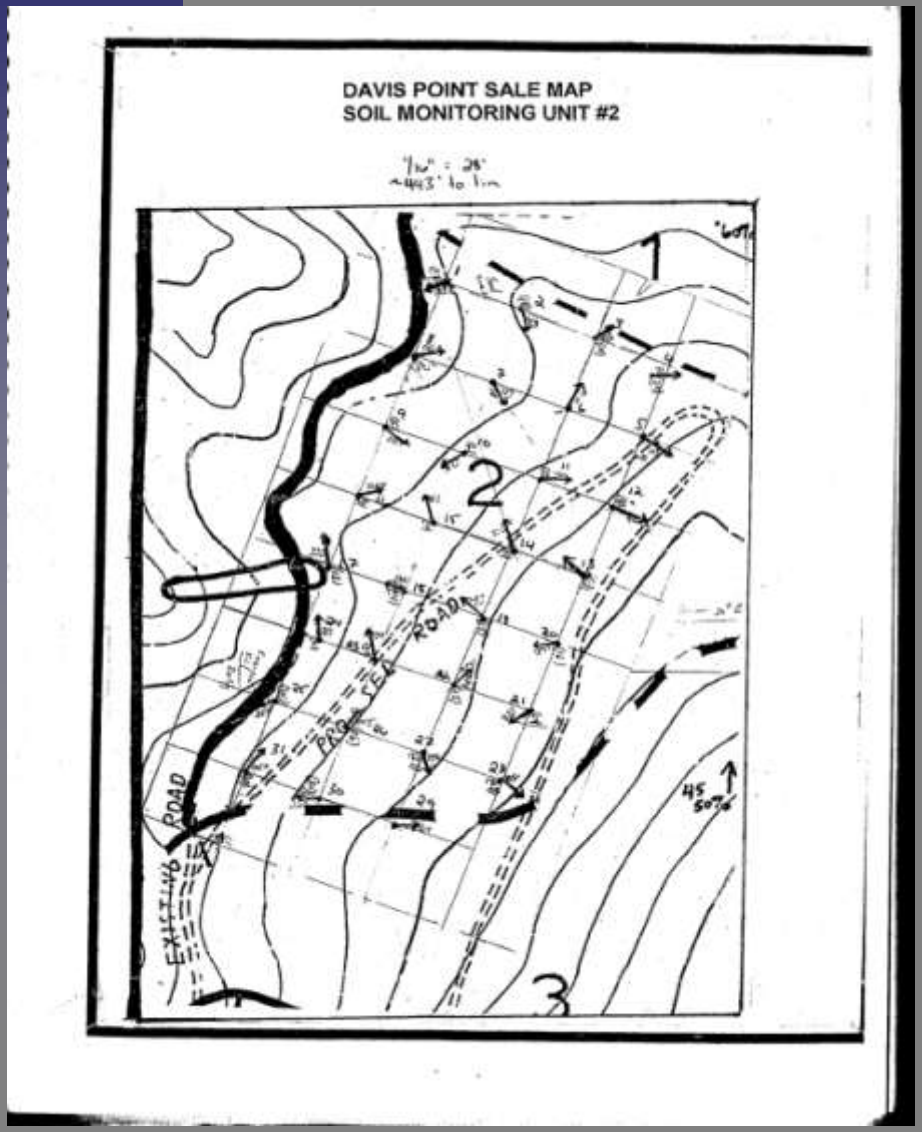
Davis Point And Coal Creek Retrospective Studies

Davis Point Soil Monitoring

Coal Creek State Forest

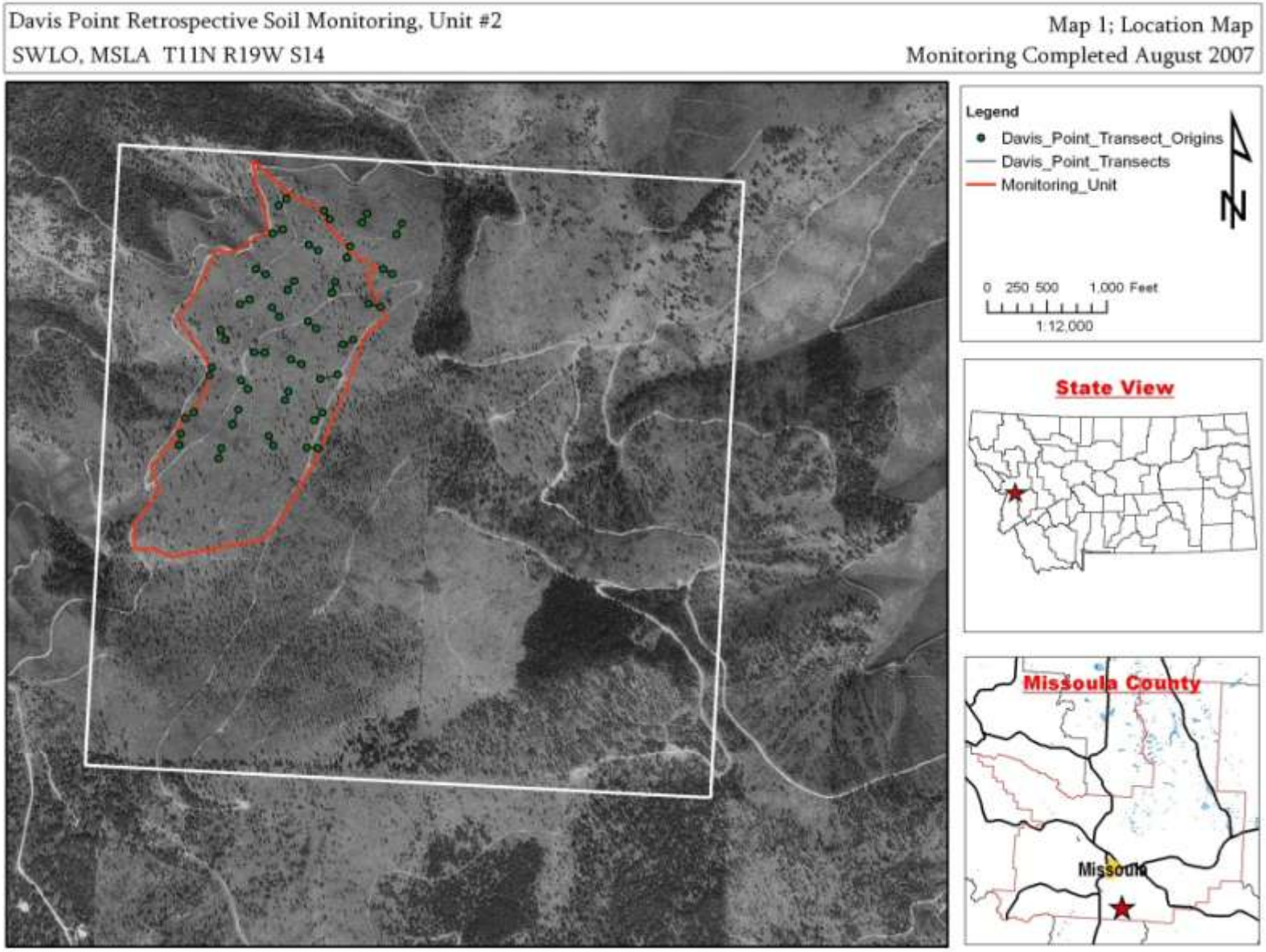
Beyond Soil Disturbance Monitoring

Davis Point Timber Sale



- Original soil monitoring map that transect lines were located from.
- Monitoring was originally completed in July of 1987. Retrospective monitoring was completed 20 years later...almost to the day.
- Seed tree harvest, dozer piled with traditional tractor harvest methods.

Beyond Soil Disturbance Monitoring

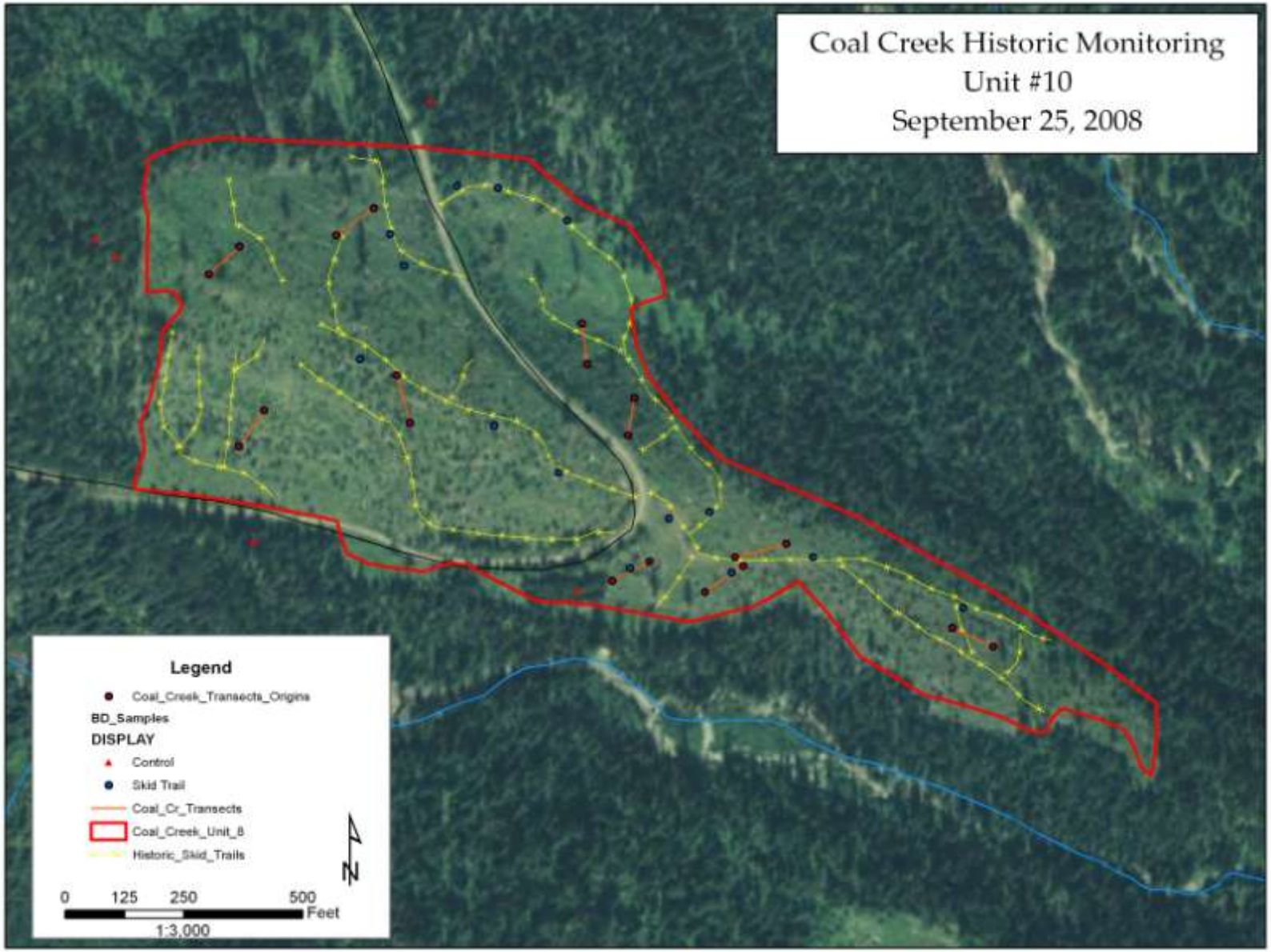


Beyond Soil Disturbance Monitoring

What does this mean for cumulative effects from displacement and compaction?

- Displacement was shown to have been naturally ameliorated in 20 years with two entries from 19.0% to 2.0%.
- Disturbed areas most likely revegetated rapidly in the year immediately following the entry.
- Compaction measurements actually INCREASED from original monitoring results from 7.2% in 1987 to 12.0% in 2007.
- The reason for this is 15+ years of grazing on the parcel after harvest.

Beyond Soil Disturbance Monitoring



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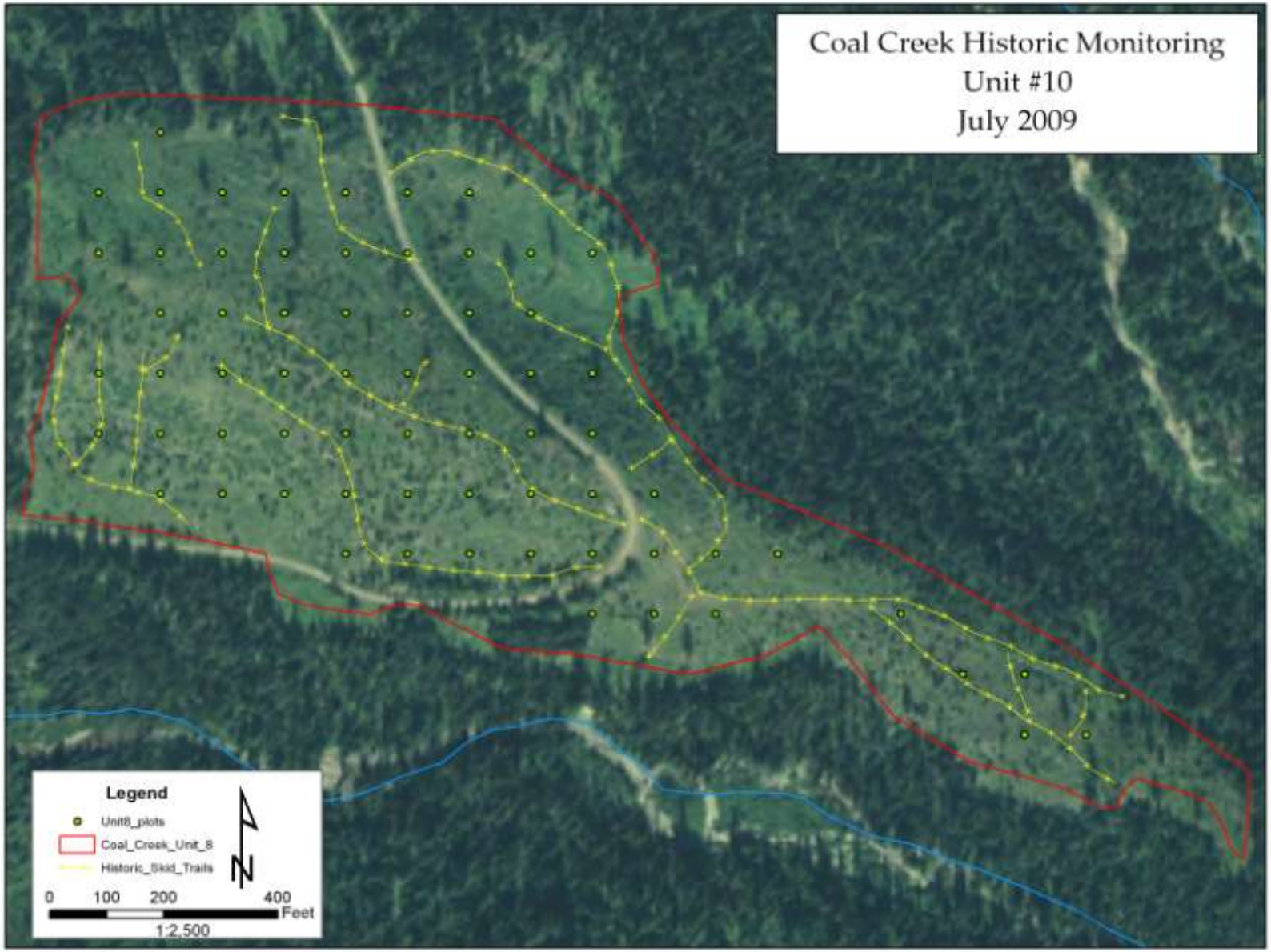

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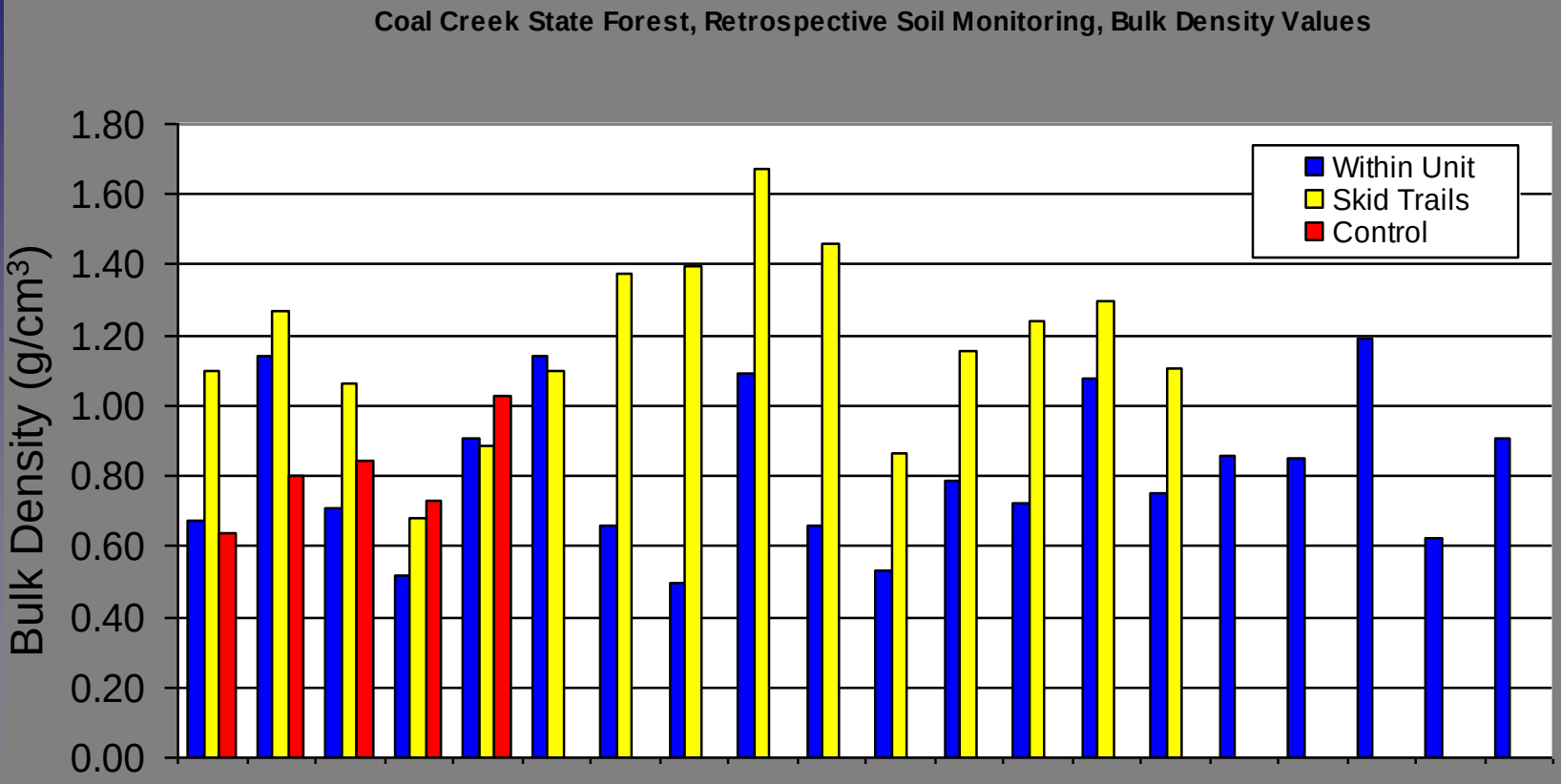
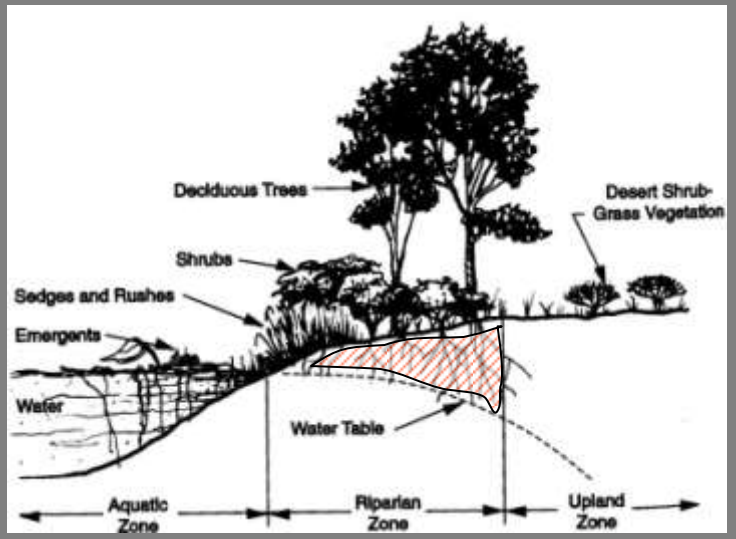


Statistics	*Average*	*SD*	*Min*	*Max*	*Range*
Within Unit	0.814	0.2203	0.50	1.19	0.69
Skid Trails	1.178	0.2537	0.68	1.67	0.99
Controls	0.807	0.1459	0.63	1.03	0.39

Point #3: Limit magnitude of impacts on skid trails with slash mats and minimize the length of skid trails to the extent possible.

Beyond Soil Disturbance Monitoring

Dog-To-Dog Timber Sale
Riparian Soil Temperature



Incoming Solar; Direct Shortwave Radiation

Riparian Shading

Diffuse Outgoing Longwave Radiation

Riparian Microclimate

Water Temp

Conductive Exchanges

Hyporheic Exchange

Riparian Soil Temperature?

Beyond Soil Disturbance Monitoring

Pre-Harvest

Quadratic Mean Diameter (QMD) = 6.8 in

Trees Per Acre (TPA) = 903

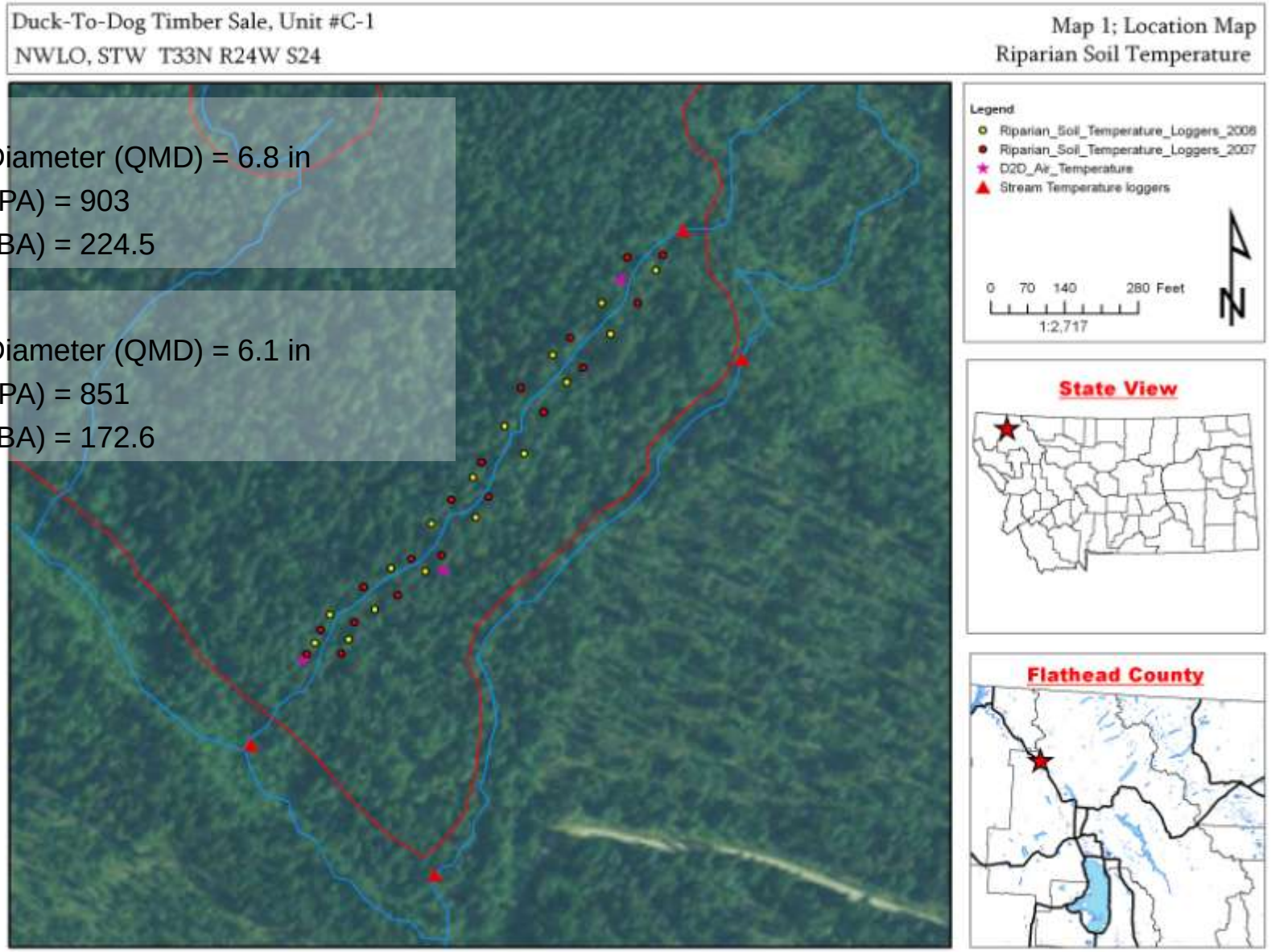
Basal Area/Acre (BA) = 224.5

Post-Harvest

Quadratic Mean Diameter (QMD) = 6.1 in

Trees Per Acre (TPA) = 851

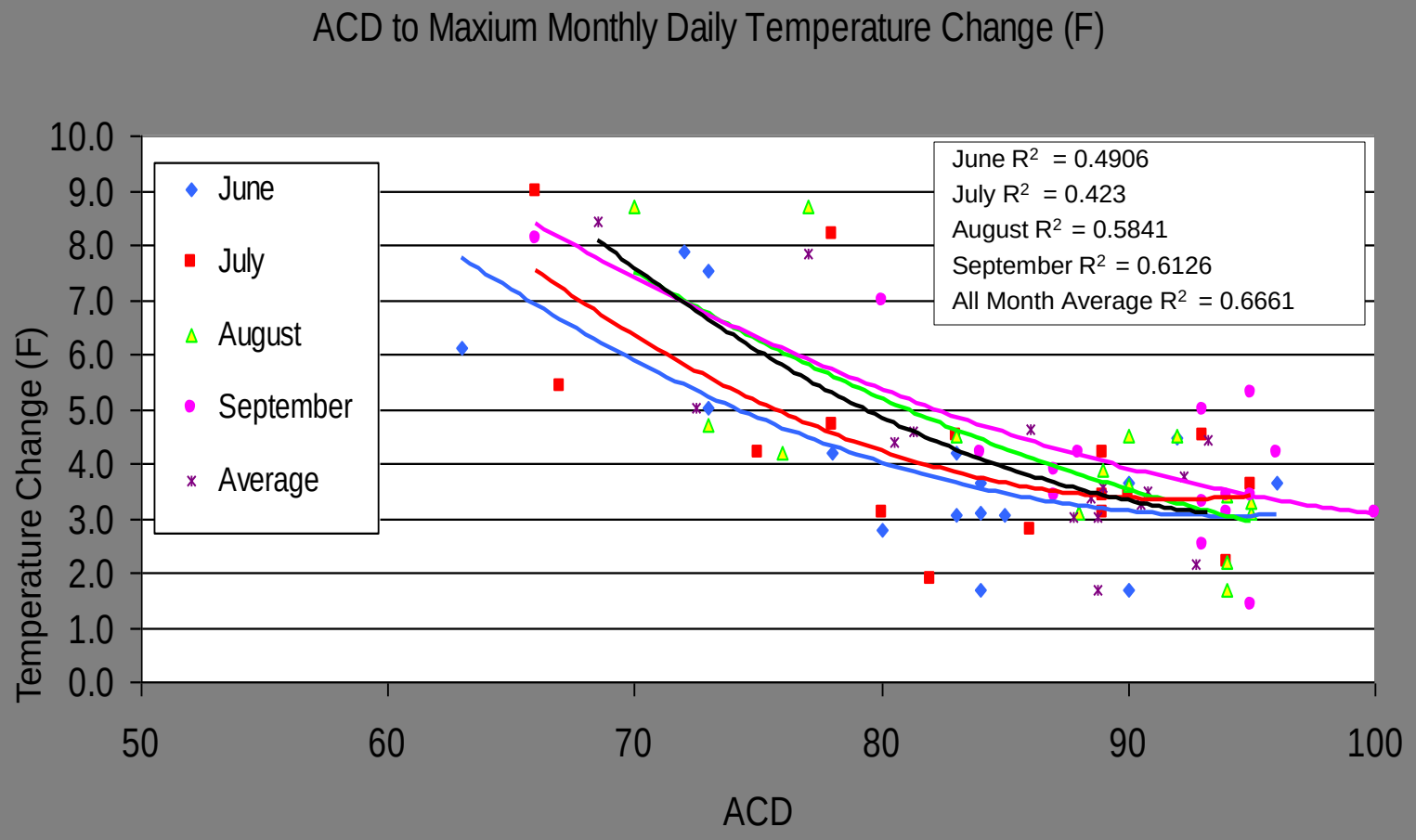
Basal Area/Acre (BA) = 172.6



Beyond Soil Disturbance Monitoring

Duck-To-Dog Riparian Air Temperature Loggers

Beyond Soil Disturbance Monitoring



Point #4: Angular Canopy Density greater then 60% seems to have minimal control on soil temperature. Sivilcultural prescription will largely dictate the amount of shade at a site.

Beyond Soil Disturbance Monitoring

Nutrient Management Implementation

Stand Types	FWD (Tons/acre)	CWD (Tons/acre)	Total (Tons/acre)	FWD/Total Ratio	Graham et al. Recommendations
Douglas-fir	7.1	8.8	16.0	45%	12-24 tons/acre
Grand fir	3.8	7.0	10.8	35%	7-14 tons/acre
Lodgepole pine	8.6	12.8	21.3	40%	N/A
Ponderosa pine	3.7	1.4	5.1	73%	7-13 tons/acre
Spruce	7.2	5.1	12.3	59%	12-24 tons/acre
Subalpine fir	1.7	7.8	10.2	16%	12-24 tons/acre
Western red cedar	7.2	23.2	30.4	24%	16-33 tons/acre
Averages	**5.6**	**9.4**	**15.2**	**42%**	**N/A**

Point #5: FWD retention, as a percent of the total woody material, should represent crown ratios of the existing stand. Implementation is then addressed by retaining tops of every X skid load to achieve desired fines.

Beyond Soil Disturbance Monitoring

Point #1: Keep it POROUS, IN PLACE, and ORGANICALLY RICH. Different equipment, topographies, climates, soils and operators will dictate the extent and magnitude of impacts.

Point #2: Multiple stand entries, if not properly mitigated and administered, have to potential to cumulatively effect soil physical properties.

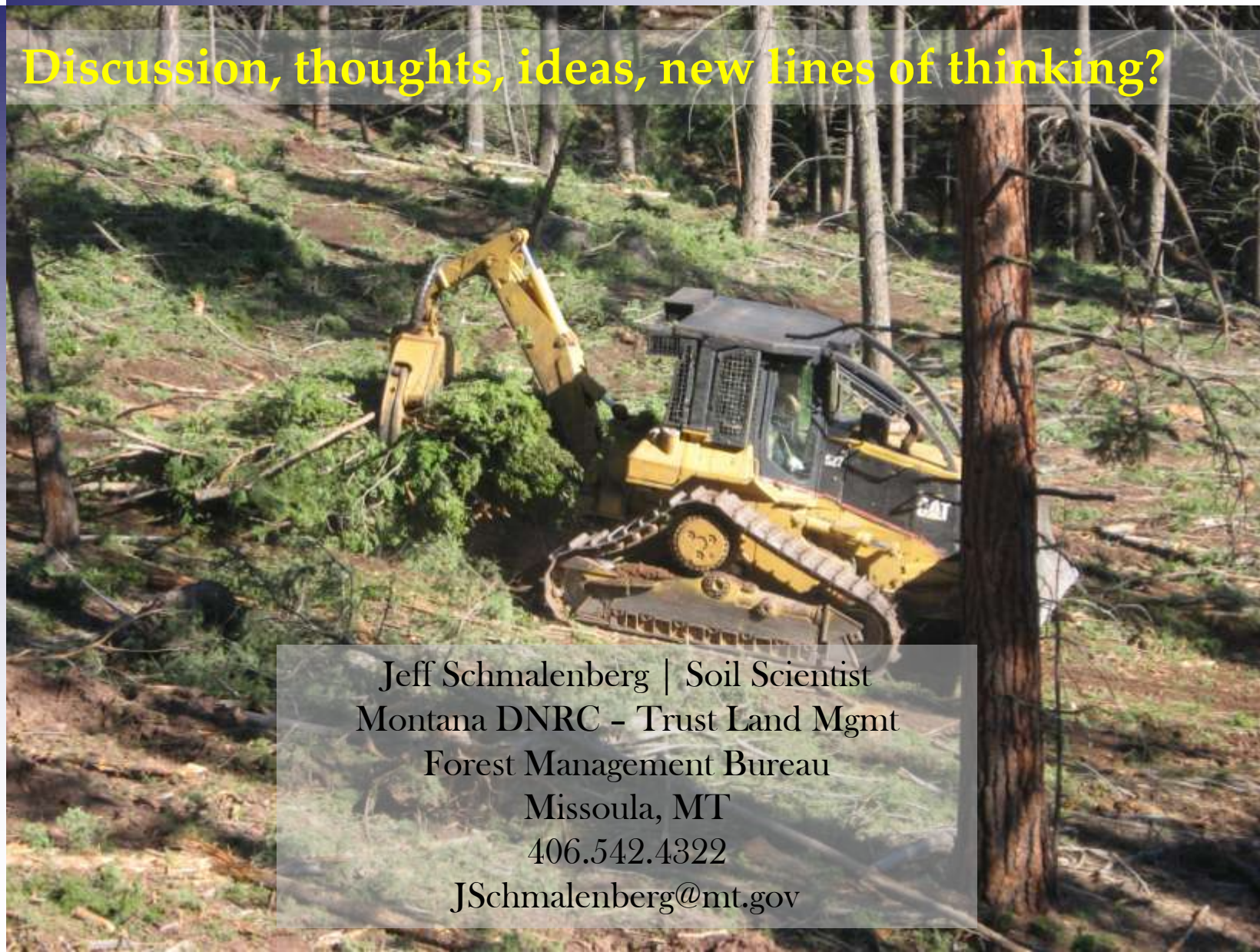
Point #3: Limit magnitude of impacts on skid trails with slash mats and minimize the length of skid trails to the extent possible.

Point #4: Angular Canopy Density, greater then 60%, seems to have minimal control on soil temperature.

Point #5: FWD retention, as a percent of the total woody material, should represent crown ratios of the existing stand. Implementation is then addressed by retaining tops of every X skid load to achieve desired fines.

Moving Forward

Discussion, thoughts, ideas, new lines of thinking?



Jeff Schmalenberg | Soil Scientist
Montana DNRC – Trust Land Mgmt
Forest Management Bureau
Missoula, MT
406.542.4322
JSchmalenberg@mt.gov